TITLE: Low Temperature Poly-Si TFT Characteristics in the Overlapped Area of Excimer Laser Long-Axis Scans

Low temperature poly-si TFT characteristics in the overlapped area of excimer laser long-axis scans

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ABSTRACT

We have investigated the laser crystallized LT poly-Si TFT characteristics in the overlapped area of excimer laser scans in the long axis direction. Continuous TFTs located at the edges of single scan and overlaps of two scans were used. Different laser energy densities were dual-scanned to study the characteristics of the TFTs in overlapped area. It was found that the laser with higher energy density dominates the TFT characteristics, and their characteristics in the overlapped area can be as good as those in the non-overlapped area. Based on these results, large uniform LT poly-Si panel can be fabricated by overlapping the laser scans in the long axis direction.

Keywords: Low Temperature Poly-Si TFT, Excimer Laser, Long Axis

1. INTRODUCTION

Because of the capability of implanting CMOS driver on cheap glass substrate, low temperature poly silicon (LTPS) crystallized by excimer laser was studied for many years. Several critical processes are needed to achieve high performance TFT like laser crystallization [1]~[9]. At this moment, scanning mode excimer laser annealing is the most popular method for mass production of LTPS panel, however, the length of laser beam generally limited the panel sizes.

In this study, we overlapped two laser scans in the long axis direction and characterized the TFTs located at the overlapped area. It was found that the laser with higher energy density dominates the TFT characteristics, and their characteristics in the overlapped area can be as good as the non-overlapped area. Based on these results, large uniform LT poly-Si panel can be fabricated by overlapping the laser scans in the long axis direction

2. EXPERIMENTS AND RESULTS

Figure 1 shows the typical transfer characteristics of our n-type single-gate TFT with W/L of 20/20um. Its high mobility and low leakage current are sufficient for driver and pixel applications.

Figure 2 shows the continuous TFTs design in this study. The pitch of poly-Si islands is 25um and the spacing is 5um to detail sampling of the TFT characteristics in the concerned area. The total length is 3.6mm and contains 144 individual TFTs.

The edge of the Excimer laser beam (L× W = 60mm× 2mm) was parallel irradiated on these TFTs by 255mJ/cm^2, 98% overlap in scanning direction (shot to shot advance equals 40um) and 150 Hz repetition rate. Figure 3 illustrates geometry of these continuous TFTs in the scanned area.

2.1. TFT Characteristics in the Edge of Laser Beam

In Figure 4, the TFT characteristics of each edge of the laser beam were shown. Each parameter was normalized with the parameters characterized from the TFTs in the central of the laser beam. The threshold voltage (Vth) and sub-threshold swing (SS) were increased and the mobility (μ) and the minimum leakage current (Imin, Vd=10V) were degraded at the beam edge, because of the trapezoidal slope of the laser energy density at the beam edge. At the beam edge, the lower energy density gives lower mobility, higher threshold voltage and poorer sub-threshold swing that represents smaller poly silicon grains and worse crystallinity. The unbalanced beam energy also can be found in this figure, the energy density in the right beam edge is higher, inversely, in the left is lower respect to the central of the laser beam. Therefore the better TFT characteristics were obtained in the right beam region. The slope region of beam is different in the left and right beam edge, however, it was believed caused by the non-uniformity of the homogenizer of laser system.

2.2. TFT Characteristics in the Overlapped Area of Laser Beam

Two scans of laser with the same energy density were irradiated and side-by-side overlapped by 2mm as illustrated in Figure 3. The overlap area was precisely irradiated on the continuous TFTs. Characteristics of one set of continuous TFTs in which two laser scans overlapped were shown in Figure 5.

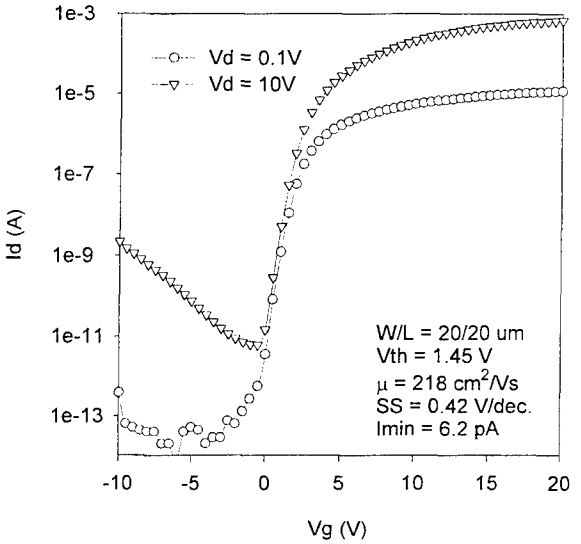


Figure 1. Typical TFT Id-Vg curves.

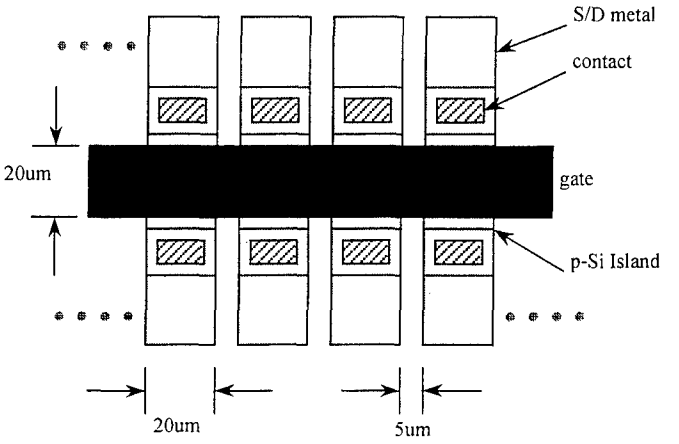


Figure 2. Design of continuous TFTs.

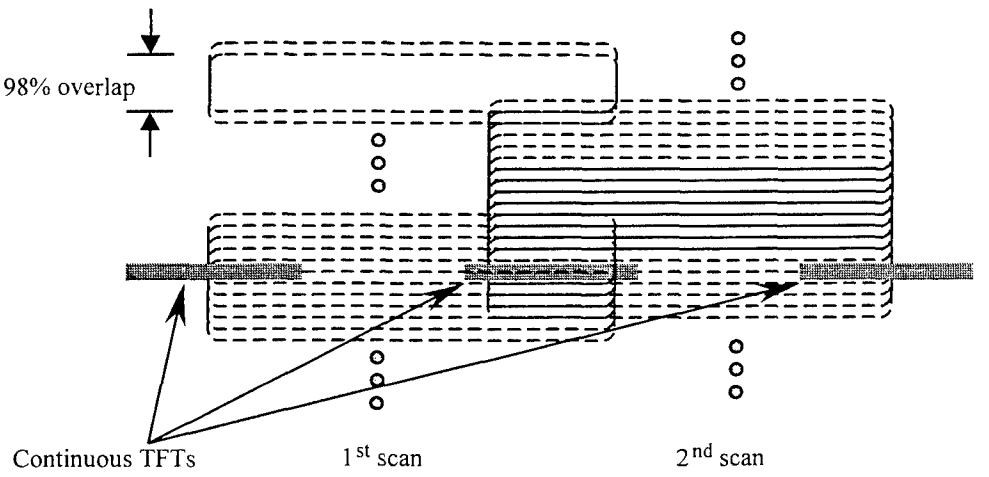
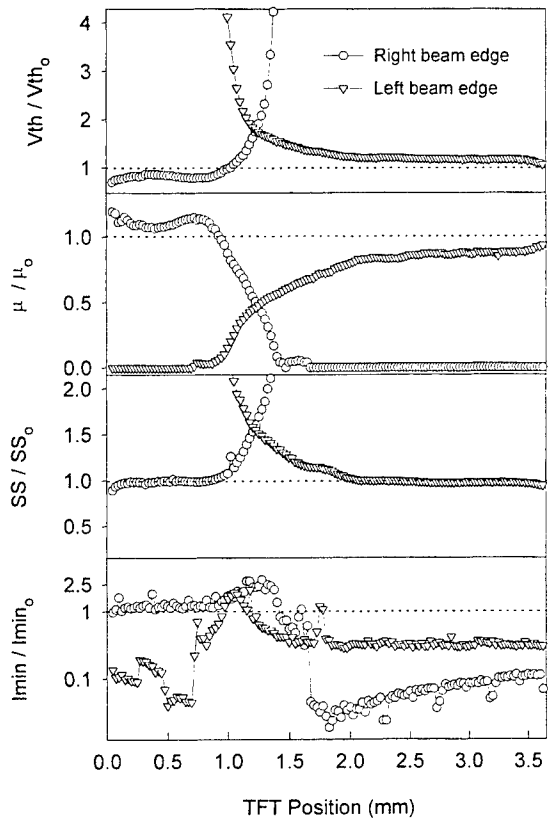
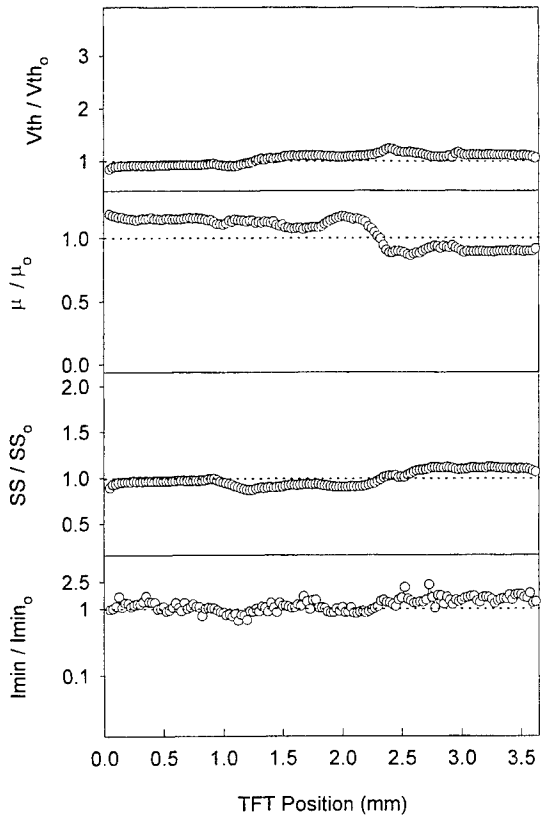


Figure 3. Geometry of TFTs in the scanned area.

The parameters like Vth, μ, SS and Imin are almost the same as the TFTs in the central of laser beam. The slope region of laser beam in the first scan was disappeared by irradiating the second scan, on the other hand, the TFT characteristics were not effected by the slope region of the second scan. The result indicates the TFT characteristics were dominated by the higher energy density of laser, and the latter lower energy density of laser irradiated on the crystallized poly silicon film did not affect the TFT characteristics.





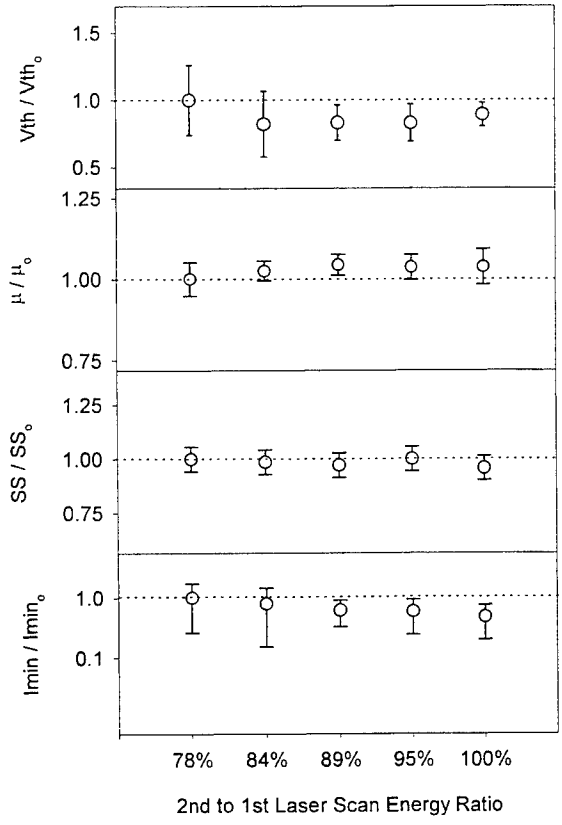


Figure 4. | **Figure 5.**

Figure 6.

Figure 4. TFT characteristics at beam edge.

Figure 5. T TFT characteristics at overlapped area.

Figure 6. TFT characteristics in dual-scanned area with different 2nd scan energy densities.

2.3. Characteristics of Dual-Scanned TFTs

To verify that the TFT characteristics were not effected by latter lower laser energy density, poly silicon films crystallized by the same laser energy density were irradiated again by different lower laser energy densities and the dual-scanned results were shown in Figure 6. Etch parameter was normalized by the parameter that extracted form the single-scanned TFTs. From this figure, the dual-scanned TFT characteristics are almost the same comparing with single-scanned TFTs', i.e., the TFT characteristics are dominated by higher laser energy density.

3. CONCLUSION

According the discussed results, the TFT characteristics in the overlapped area can be as good as non-overlapped area, and large uniform LT poly-Si panel can be fabricated by overlapping the laser scans in the long axis direction.

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